InLCA: Life Cycle Inventory Development

Current LCA Database Development in Japan – Results of the LCA Project

Nobuhiko Narita*, Yoshifumi Nakahara, Mamoru Morimoto, Ryosuke Aoki and Shigeru Suda

Japan Environmental Management Association for Industry, 1-17-6 Ueno, Taito-ku, Tokyo, Japan

* Corresponding author (narita@jemai.or.jp)

Abstract

DOI: http://dx.doi.org/10.1065/lca2004.09.180.3

In 1998, the Japan's Ministry of Economy, Trade, and Industry (METI) launched a five-year national project entitled 'Development of Life Cycle Impact Assessment for Products' (commonly known as 'the LCA Project'). The purpose of the project is to develop common LCA methodology as well as a highly reliable database that can be shared in Japan. Activities over these five years have resulted in the supply of LCI data on some 250 products. Industrial associations voluntarily provided data. The results of these activities are currently being made available on the Internet on a trial basis in the form of an LCA database. In addition, a method entitled 'Life-cycle Impact assessment Method based on Endpoint modeling (LIME)' was developed. It is expected that these results will be widely used in Japan in the future. This paper presents an outline of the results of the research and development that has been conducted in the LCA Project in Japan.

Keywords: Japan; LCA database development in Japan; LCA methodology; LCA project Japan; LCI data; LCIA for products; LCIA method based on endpoint modeling (LIME)

Introduction

Based on the policy statement of the LCA Japan Forum, which was established within the Japan Environmental Management Association for Industry (JEMAI) in 1995, the LCA Project was initiated in 1998 with support from the Ministry of Economy, Trade, and Industry (METI) and New Energy and Industrial Technology Development Organization (NEDO) [1]. Intended to develop LCA methodologies, gather data from industrial associations into a highly reliable database, and develop a network system, the five-year LCA Project engaged in research and development to provide the infrastructure needed for the practical application of a highly dependable LCA. A Project Steering Committee comprised of experts from industry, government, and academia was established within JEMAI. Three committees were set up under the supervision of the Project Steering Committee: 1) an Inventory Study Committee (made up of 22 participating industrial associations), 2) an Impact Assessment Study Committee, and 3) a Database Study Committee. These committees were charged with carrying out development activities.

1 Implementation Framework

The LCA Project was implemented using the framework shown in **Fig. 1**. The Inventory Study Committee collected data on product production as well as on waste and recycle processes. The Impact Assessment Study Committee developed environmental impact assessment methods that are based on damage computation. And the Database Study Committee developed software for placing the above-mentioned database on the Internet. The following is an overview of the results of each committee's activities.

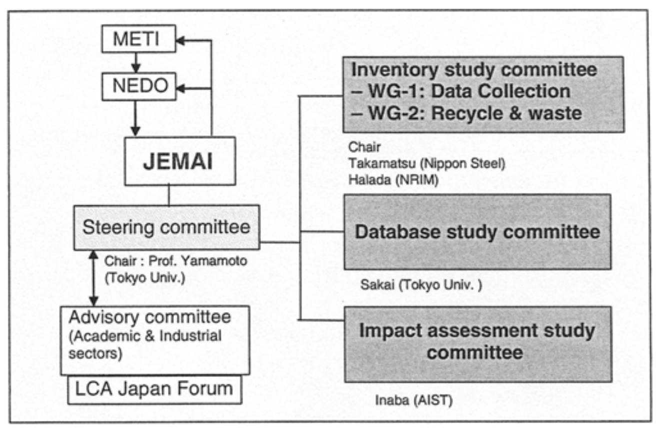

Fig. 1: Organization of the LCA project

2 The Inventory Study Committee

As shown in Fig. 1, the Inventory Study Committee was comprised of two Working Groups: WG1 collected inventory data on product production, and WG2 surveyed inventory data on waste and recycling processes.

2.1 Collection of inventory data on product production

One feature of inventory data collected through the LCA Project is that it is comprised of data supplied voluntarily from industrial associations. As shown in **Fig. 2**, these industrial associations cover a wide range of fields, from extraction of resources to assembly-related industries such as materials manufacturing and automobiles. WG1 prepared a data collection manual so that data could be gathered using a common method whenever possible. This manual called for the collection of inventories of companies belonging to

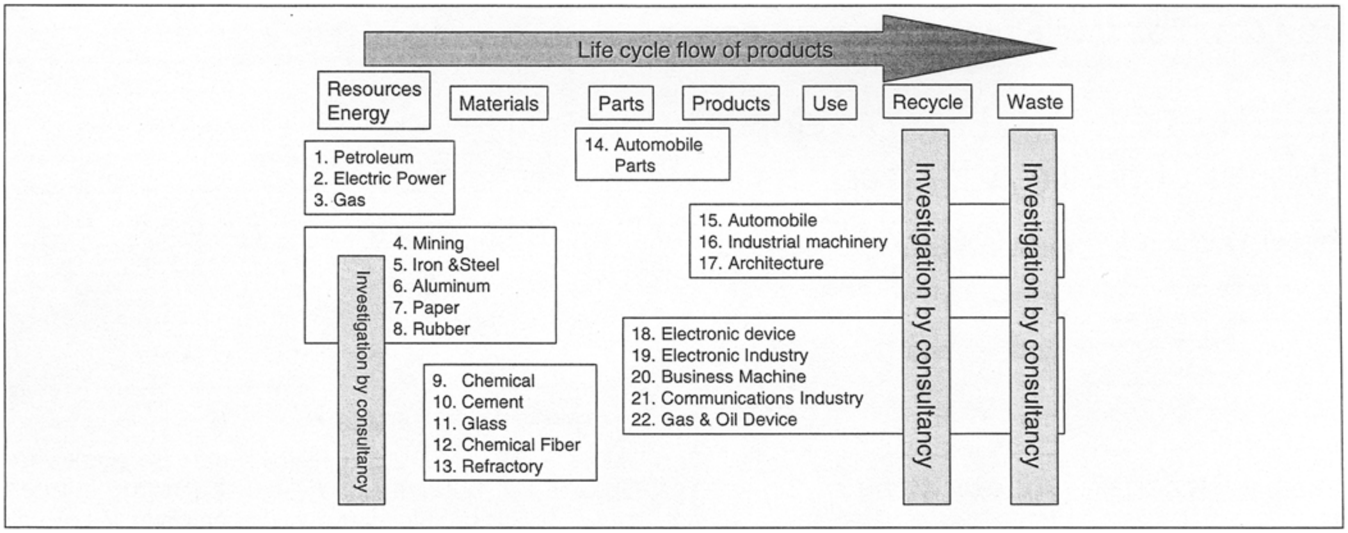

Fig. 2: Industrial associations participated in LCA project

industrial associations. Although figures varied depending on the product, WG1 succeeded in collecting inventory data for at least 60% of the production share of each product. Consequently, WG1 was able to collect background data in Japan that is highly reliable.

As is shown in **Fig. 3**, each industrial association gathered input and output data of unit processes in its member companies into a single subsystem, which it voluntarily provided to the project as inventory data related to product production.

Collection and input of data was carried out according to the following procedure:

a. Establishment of inventory items
b. Establishment of data collection fields and the industrial associations responsible for each field
c. Determination of collection strategies for gathering insufficient data (making requests to other industrial associations, etc.)
d. Preparation of a data collection manual and format
e. Preparation of data collection software and a manual
f. Collection of data by industrial associations
g. Quality check of inventory data
h. Establishment of methods for opening and operating the database

As can be seen from this procedure, because the system boundaries for the inventory data of each industrial association follow the 'Gate-to-Gate' concept, database users can conduct inventory analyses by linking data on their own initiative.

After collecting data from the 22 participating industrial groups as well as the other cooperating industrial groups, a task group established within WG1 reviewed the data to confirm compliance with the data collection manual. A public database was then prepared. As a result, inventory data was obtained on a total of roughly 250 industrial products from over 50 industrial groups at the sub-system level.

Looking at the results of a study of emissions data provided from all industrial groups, which targeted 14 substance flows into the environment (air: CO_2, CH_4, HFC, PFC, N_20, SF_6, NO_x, SO_x, soot; water: BOD, COD, total phosphorus, total nitrogen, suspended substances), it was found that, while there were a few areas where data was lacking; on average, roughly 70% of the emission items were provided for the 14 flows. 14 substances are selected from importance to the global warming, the acidification and eutrophication. A portion of the data collected from these industrial groups is

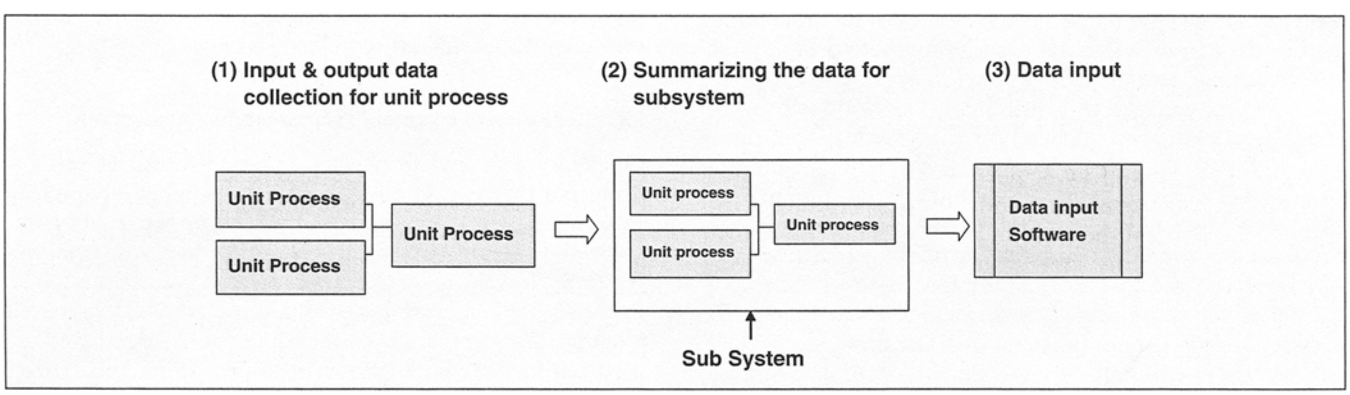

Fig. 3: Inventory data collection based on the common manual by industrial associations

Table 1: Examples of inventory data of the project

Gas	Town gas	LNG[a]				
Petroleum	Heavy oil A	Heavy oil C (low S)	Naphtha	Diesel	Gasoline	Kerosene
	Crude oil	Heavy oil C (high S)				
Electricity	Grid Mix					
Aluminum	Al pipe	Al sheet	Al foils	Al paste		
Chemaical	PET	PS	PP	PVC	HDPE	LDPE
Iron & Steel	Shapes	Plate	Bars	Zn coated sheet	Hot rolled coil	Cold rolled coil
	Weld pipes	Tin free steel	Tin plate	Ni-based stainless	Cr-based stainless	
Glass	Plate glass					
Cement	Portland cement	BF cement	Fly ash cement			
Refractories	Burned refractories	Monolithic refractories				
Chemical fibres	Polyester fibers	Tire cord				
Non-ferrous metal	Copper	Lead	Zinc			
Rubber	Tire for automobile	Tire for truck	Tire for bike			
Paper	Paper	Board				
Building constructor	Business office					
Gas & kerosene appliances	Oven	Fan heater	Water heater	Stove	Cockle	
Industrial machinery	Pump	Blower				
Automobile	Automobile (1500CC)					
Automobile parts	Fuel tank	Brakes	Car air-conditioner	Drive shaft	Crutch	Converter
Business machine	Copying machine					
Electronic	Color TV	Desk top PC	Laptop PC			
Communications	Handy phone					
Electrical for households	Refrigerator					

[a] Liquified Natural Gas

compiled into **Table 1**. A large amount of inventory data was supplied by the energy industry (petroleum, electricity, etc.), materials industry (iron and steel, etc.), and assembly industry (automobiles, etc.).

WG1 also performed an independent survey that was in addition to the efforts of the industrial groups to provide inventory data. This survey collected data on resources extraction, energy, transport, and transport as well as processing process data for metals and plastic as inventory items that can be used jointly for manufactured products. These data include the inventory for minig process in foreign countries and so on, because the inventory in the foreign countries is difficult to be collected by the industrial association.

2.2 Collection of inventory data on waste and recycling [2]

WG2, which collected LCI methodologies and inventory data in the recycling and waste processes, established the following items in order to clarify LCI methodologies in the 'waste management and recycling sectors'.

a. Attitude with regard to recycle rates
b. Modeling of waste treatment data
c. Attitude regarding inventory if waste is dumped

Furthermore, WG2 conducted a fact-finding survey on materials flow in the following sectors:

d. Survey of intermediate disposal processes in accordance with materials flow at the waste/recycling stage
e. Unit survey on environmental burden in waste disposal (incineration, landfill, etc.)

2.2.1 Preparation of a model for estimating environmental load in incineration and landfill

Based on analyses of 'collection and transport', 'incineration', 'waste composition', and 'air pollutants' conducted by local governments, WG2 prepared inventory data as a model for estimating environmental load that can be used in determining load coming from both products and processes.

2.2.2 Preparation of a model of waste and recycling inventory data

WG2 ran a model based on actual measurement data on intermediate disposal processes that targeted each of the following: used bicycles, household appliances, office automation equipment, and construction waste. It then prepared an inventory.

2.2.3 Preparation of a model of inventory data related to detoxification of heavy metals

WG2 conducted a survey based on tests of detoxification processes (separation and collection of heavy metals from incineration fly ash) and other activities for landfill. It then estimated inventories for the detoxification process using wet-type (smelting) disposal. The heavy metals focused on here were Cu, Pb, Zn, Cd, and Hg. The data on these metals were used as reference data in examining the recycling-type LCI.

3 Database Study Committee [3]

The Database Study Committee developed software for inputting collected data that was supplied to all of the industrial groups. The industrial groups that supplied data to the project used the software to compile a database by inputting inventory data for their major products. In addition, the committee constructed a system that can provide the LCA database to users using electronic means. A conceptual diagram is presented as **Fig. 4**.

This system is comprised of data-input clients, a database server, and a server for providing data. The committee confirmed the operation of a) user registration, b) user authorization, c) access control, d) data searches and downloads, and e) management tools, etc., before building the database system.

4 Impact Assessment Committee

The Impact Assessment Committee conducted research and development toward the creation of a damage-calculation based impact assessment system for Japan. The system takes the following two approaches:

a. Natural-scientific approach to conducting quantitative evaluations on the amount of actual damage on safeguard subjects from environmental load → classification, characterization
b. Social-scientific approach toward the study of evaluators' attitudes: Which items of the safeguard 1subjects receiving environmental impact are important? What degree of impact is significant? → weighting for the purpose of integration

The following is an overview of research results gleaned from the above-mentioned approaches [4,5,6,7].

The Impact Assessment Committee selected 11 impact categories related to damage of four safeguard subjects (human health, biodiversity, primary productivity, social assets). These were: global warming, destruction of the ozone layer, acidification, photochemical oxidants, urban air pollution, harmful chemicals, ecotoxicity, eutrophication, land use, resource consumption, and waste. It then prepared a list of characterization factors in order to link emission of substances having environmental load with environmental categories, then selected factors for recommendation to this project. In addition, damage experts and other members of the Damage Function Committee studied methods for computing damage in their fields of specialization for each impact category and quantified each type of environmental damage. As a result, the committee was able to propose damage factors for each of the safeguard subjects.

Furthermore, four safeguard subjects were set up in research on integrated evaluation methods. These were: a) human health, b) social assets, c) biodiversity, and d) primary productivity. Using the 'conjoint analysis method', the Impact Assessment Committee implemented a comparison of priority among these safeguard subjects and formulated integration indicators. The relationships among the impact categories, damage amounts, and safeguard subjects are shown in **Fig. 5**.

Through the above-mentioned R&D, the Impact Assessment Committee compiled a list of three factor types for environmental categories as LIME. These were: a) grouping of environmental categories, b) amount of damage to safeguard subjects, and c) integrated evaluation. It will be necessary to conduct a detailed study of these proposals by putting them to wide-ranging application, and to firmly establish them as an evaluation method.

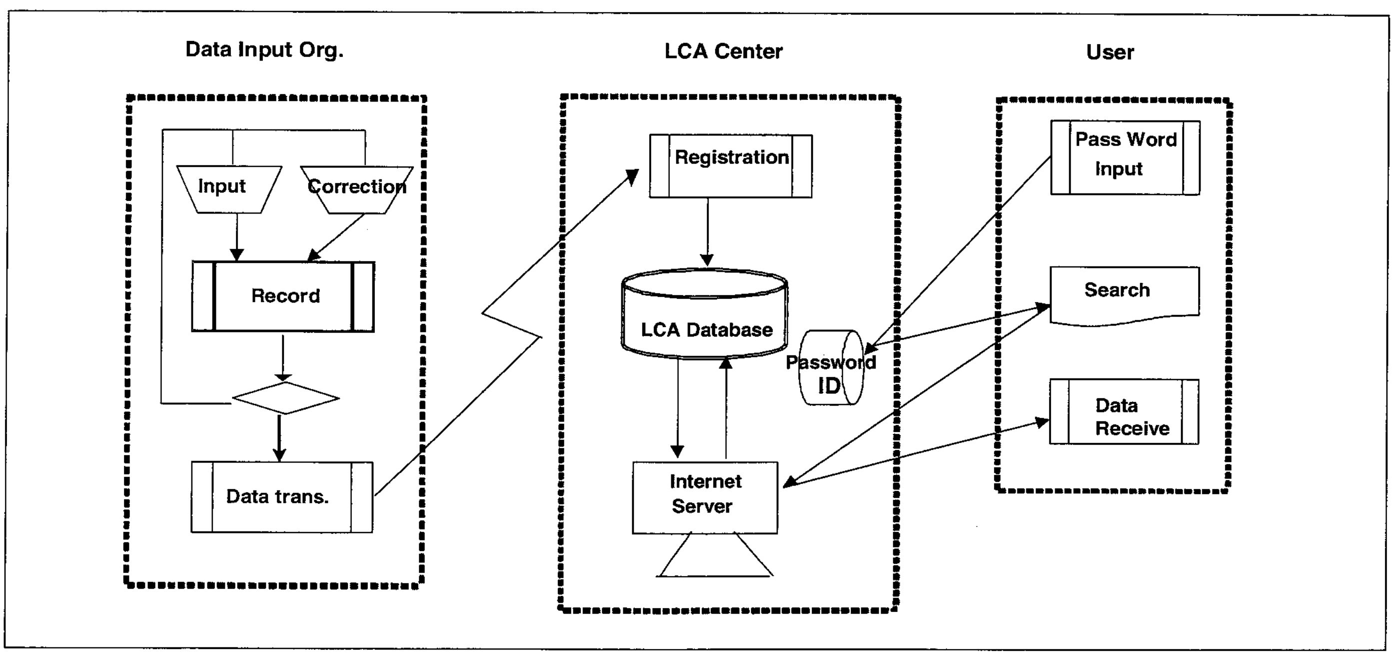

Fig. 4: Nework system of LCA database

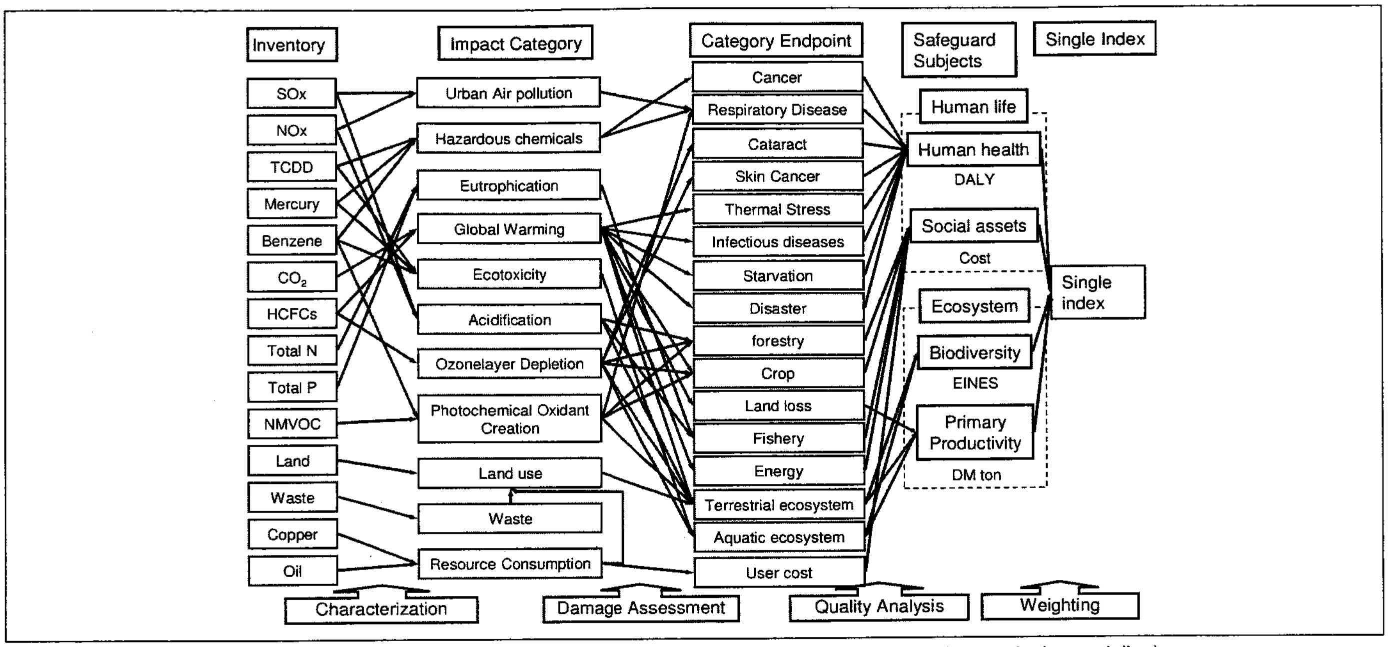

Fig. 5: Conceptual figure of LIME (life-cycle impact assessment method based on endpoint modeling)

5 Trial Release of the LCA Database to the Public

From August 2003, the results of this project have been made available to the public on a trial basis as the LCA database. The database can be accessed through the Japan Environmental Management Association for Industry website (http://lcadb.jemai.or.jp/). The purpose of this trial is to determine what will be required of the LCA database in Japan and to ascertain areas where it is insufficient. People wishing to access the database will be required to register as database members. Although the database has been prepared in Japanese only, over 1,500 people from industry and the researcher community are currently registered. These people are using the database for background data that can be shared in Japan. The inventory data will be updated when necessary. It is expected that, in the future, the LCA database will be managed by the LCA Society of Japan, which will further improve its effectiveness.

Fig. 6 presents an outline of the content currently available through the database. In addition to the above-mentioned inventory data provided by the industrial groups, survey data, and LIME factor tables, the database contains documentary information released by International Conferences on Ecobalance and other meetings so that it may be useful to persons working in LCA.

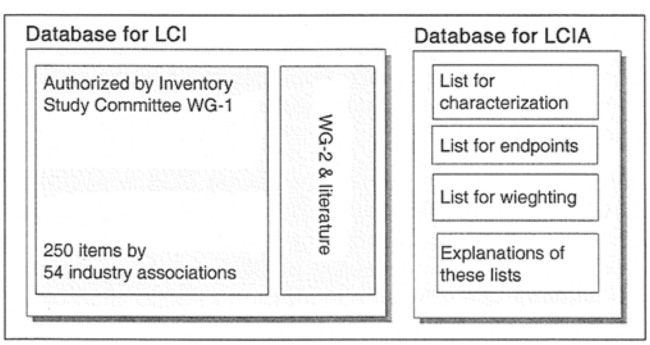

Fig. 6: Contents of the LCA database in Japan

6 Conclusion

With the purpose of building an LCA infrastructure in Japan, the research and development of the LCA Project was conducted over a 5-year period, beginning in 1998. Since August 2003, an LCA database has been made available to the public on a trial basis. The database is made up of 'Gate to Gate' inventory data that was voluntarily provided by industrial association. It also includes LIME factor tables, and other items.

An increasing number of Japanese companies are gaining greater understanding and awareness of LCA and are moving to introduce LCA methods. These are in addition to the participating industrial associations and their member companies that participated in the project over its five-year period. In addition, expectations for the LCA database utility is exceeding what was originally planned at the beginning of the project. Therefore, it will be necessary to tackle a number of issues (such as further enhancement of data, detailed study, etc.) in order to expand the use of the LCA database.

References

[1] Yano M, Aoki R, Nakahara Y, Itsubo N, Ohta T (2000): Int J LCA 5 (5) 261
[2] Itsubo N (1999): Int J LCA 4 (5) 246
[3] Nakahara Y (1999): Int J LCA 4 (6) 310
[4] Itsubo N (1999): Int J LCA 4 (4) 194
[5] Hayashi K, Itsubo N, Inaba A (2000): Int J LCA 5 (5) 265
[6] Itsubo N, Inaba A, Matsuno Y, Yaui I, Yamamoto R (2000): Int J LCA 5 (1) 5
[7] Itsubo N, Inaba A (2003): Int J LCA 8 (5) 305

Received: June 16th, 2004
Accepted: September 27th, 2004
OnlineFirst: September 28th, 2004